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On efficiency, concentration and welfare

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Abstract

The welfare impact of a merger involves the market power offense and the efficiency defense. Salant et al. (1983) show that mergers among symmetric firms are unprofitable except for monopolization. We characterize the limit to this merger paradox in a simple linear Cournot oligopoly with asymmetric costs. Farrell and Shapiro (1990) provide sufficient conditions for a profitable merger to increase welfare but leave open whether it exists. We characterize the degree of cost asymmetry making a merger both profitable and socially desirable. Comparing rationalization and synergy within the efficiency defense, we show that for most industry structures, a rationalization merger is more likely to be welfare enhancing but a synergy merger is more likely to be profitable.

Keywords: merger, efficiency, concentration, welfare, antitrust, competition.

JEL Classification: L40, D43, D24

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1 Introduction

1.1 Overview

Thousands of mergers and acquisitions occur every year, many of them drawing the attention of the media and antitrust authorities. The controversy around these concentration operations can be synthesized as follows: a merger is guilty of the *market power offense* but may be absolved by the *efficiency defense*.

In their pioneering paper, Salant et al. (1983) assess the market power effect of a merger and show, in a symmetric Cournot framework, that mergers are unprofitable except for monopolization.[1] Because so many mergers are still profitable for their promoters (about half according to empirical studies), there would be a paradox unless cost saving efficiencies are systematically involved. This is commensurate with the ample evidence on large and persitent productivity differences among producers, even within narrowly defined industries. With respect to the literature extending Salant et al. (1983), our first contribution is to characterize the limit to the merger paradox in terms of marginal cost asymmetries (in the same linear Cournot oligopoly model).

Adopting a normative stance, Farrell and Shapiro (1990) analyze the welfare effects of an horizontal merger and provide sufficient conditions for a profitable merger to increase welfare. A positive quandary they do not address is whether there are actually any profitable mergers that are also welfare improving. As the merger paradox indicates, efficiencies must be involved; our second contribution is to characterize the degree of cost asymmetry that clears a merger in terms of welfare, thus addressing the aforementioned dilemma (in the linear Cournot oligopoly model).

Lastly, we contribute to the controversy surrounding the *efficiency defense*. Schumpeter (1942)'s famous notion of "creative destruction" is akin to *rationalization* whereby low-cost producers (or plants) gain market shares at the expense of high-cost ones, in a process of entry, exit, acquisition and mergers. In his defense of the efficiency motive for mergers, Williamson (1968) points at *synergy* whereby the newly merged firm successfully combines the previously independent assets and improve her technology.[2] This seminal paper has given the synergy theoretical concept an edge in the aca-

[1] In the linear Cournot oligopoly model, they show that a profitable merger must gather at least 80% of the per-merger market shares.

[2] An example would be merging across borders to reduce uncertainty regarding output markets, input supply, political pressure or currency risks.

demic literature on efficiency although rationalization prominently figures in the US merger guidelines and is prevalent in the empirical literature on mergers and productivity growth. Our model is simple enough to encompass both types of efficiencies and enable a fruitful comparison of their influence over the private profitability and the social desirability of a merger.

In the remnant of this introduction, we recall the methodological debate behind the efficiency defense of mergers. Then, we state our contribution and relate it to the literature. Lastly we detail our case for focusing on rationalization. The next section presents our analytical results while the third concludes.

1.2 Efficiency Controversy

Two doctrines of economic competition vie for intellectual leardership. The "Structure Conduct Performance" (SCP) paradigm, inspired by Bain (1951), focuses on allocative or *static* efficiency. It studies how firms compete simultaneously in current markets; its policy aim is to create workable competition for the present. The Chicago critic builds on Schumpeter (1942)'s concept of "creative destruction" and holds a *dynamic* view of efficiency; it studies how firms compete sequentially for the market and emphasizes innovation. A temporary monopoly that enables an innovator to recoup its investment is thus seen as a necessary evil on the path towards the higher goal of long term progress.

This controversy spills over the handling of concentration operations (mergers and acquisitions). The SCP paradigm holds a "market power" view along the following causal relationship: mergers increase firms' market power which leads to higher prices and hurts consumers. Since technologies and tastes are exogenously given, total welfare must also decrease. On that ground, significant mergers ought to be opposed.

The Chicago critic approaches mergers from two angles. The "efficiency defense" started by Williamson (1968) broadens the SCP's vision in asserting that mergers can contribute positively to welfare by bringing in efficiencies. It is also argued that the adequate criteria for antitrust authorities is (total) welfare rather than consumer surplus. More radically, Demsetz (1973) contends that the SCP confuses correlation and causation.[3] True, there is a positive correlation between market concentration and industry profitability but which one drives the other cannot be identified with a comparative statics exercise, the very tool used by the SCP paradigm. The Chicago

[3] cf. also Dewey (1961), McGee (1971) and Peltzman (1977).

schools then endorses a reverse causal chain: the more efficient (innovative) firms capture greater market shares, earn more and tend to buy out the less efficient firms (or drive them out of the market). The policy implication with respect to mergers is also reversed: allowing innovative firms to acquire obsolete ones promotes efficiency and ultimately welfare.

The academic debate spills over the real world as it influences the antitrust perception of mergers. Kovacic and Shapiro (2000) recall that until the 1970s, antitrust practitioners were in agreement with the "market power" view and sought to protect consumers from monopolization. The "efficiency defense" of mergers has then overcome initial defiance and become increasingly accepted by antitrust authorities and courts (cf. §4 in DoJ (1997) and §VII in EC (2004)). In a world where globalization has triggered mergers waves of dimensions unseen before, it is of the essence to understand the interplay between the two opposing views of efficiencies when assessing a merger.

1.3 Contribution

Our contribution is foremost a positive complement to the normative study of Farrell and Shapiro (1990) (henceforth **FS**). Using the standard staple of industrial organization, the linear Cournot model of oligopoly (e.g., Salant et al. (1983)), we show how the *efficiency defense* interacts with the *market power offense*.[4] In our static setting without entry nor exit, firms are either advanced (cutting-edge) or obsolete. The percentage welfare loss due to a switch from the efficient to the inefficient technology in the entire industry is called the *technological gap*; it is our measure of the technological asymmetry among members of the industry. We focus on bilateral mergers since other combinations are seldom observed.[5]

We start with the study of a rationalization merger whereby a cutting-edge firm buys out an obsolete one. Proposition 1 shows that a mild technological gap is sufficient for a rationalization merger to be welfare improving. This means that the loss of consumer surplus resulting from the global output contraction can be compensated by the profit increase of efficient firms (the merging one and the outsiders to the deal). The condition can also be

[4] As we emphasize in the conclusion, our findings should not be taken at face value when assessing actual merger cases given the highly stylized nature of our framework.

[5] This is probably due to the contracting costs of negotiation among shareholders. As far as theory is concerned, a merger among many firms can still be decomposed into successive bilateral mergers upon which our analysis can be applied (cf. Pesendorfer (2005) for stylized facts).

checked from market observables: the output of the absorbed obsolete firm must be less than the total excess output of efficient firms.[6]

Proposition 2 characterizes the minimum technological gap making a rationalization merger (privately) profitable; it turns out to be larger than the previous one. The reason is the one at the root of the merger paradox: the merged firm produces less than the combined output of merger participants; a strong rationalization is thus needed to compensate for the relative profit loss. Proposition 3 then restates a previously known outcome: a privately profitable merger involving at most half the industry is socially desirable. In our linear setting, the condition boils down to an industry count of at least 5 firms or exactly 4 with at least 2 efficient. Our main result regarding rationalization mergers (Corollary 1) is then the combination of these preliminary steps assuming the industry counts 5 or more firms. If the technological gap is

- *small*: no one wants to merge; this is socially desirable.
- *medium*: no one wants to merge but a rationalization merger would increase welfare.
- *large*: an efficient firm agrees to buy an obsolete one which is welfare increasing.
- *huge*: obsolete firms are expelled from the market by efficient ones.

Given the competing roles of synergy and rationalization as alternatives forms of efficiency, it is worthwhile to compare them in our limited framework. Proposition 4 characterizes the technological gap above which a synergy merger is profitable and raise welfare. We then show in Corollary 2 that for most industry structures, a rationalization merger is more likely to be welfare enhancing but a synergy merger is more likely to be profitable.

Lastly, we take a look at within-firm innovation as the ability to upgrade technology from obsolete to cutting-edge. We obtain very intuitive results: firstly, it is privately and socially desirable for an obsolete firm to become cutting-edge, secondly two obsolete firms won't merge if they cannot innovate.

1.4 Literature

Cournot (1838) introduces the model of quantity competition and observes that a firm with low marginal cost produces more than higher-cost firms,

[6]Individual excess output is the difference in production between an efficient and obsolete firm.

and that some of them might be forced to exit.[7] He also notices that a given total industry output would be produced at higher cost by competing asymmetric producers than if a monopolist made their production decisions (because their marginal costs are not equal at equilibrium).

Williamson (1968) exploits this intuition and shows that if a merger generates a synergy (i.e., marginal cost reduction) then the welfare loss due to the price increase may be compensated by the cost saving. Although the original model is crude, the intuition is so strong that it remains robust to generalizations.

Cowling and Waterson (1976) show in a Cournotian model that the average profit-revenue ratio is equal to the concentration-elasticity ratio. Although no causality can be deduced from this formula, it has been adopted as a foundation for the "market power" rationale. Clarke and Davies (1982) further show that the Herfindhal concentration index increases with the variance of firms' marginal costs; this proves that concentration is greater when some firms have a cost advantage, a result that lands support to the dynamic efficiency rationale. In the same vein, Salant and Shaffer (1999) show that if the average marginal costs in the industry is constant, then so is aggregate output and consumer surplus. When a shock makes such an industry more cost-asymmetric, concentration, aggregate profit and welfare all increase together.[8] This finding provides a rationale for government support of "national champions" at the expense of other domestic firms with the same initial technology.

Salant et al. (1983) address the profitability of mergers in the Cournot oligopoly with symmetric marginal cost and show that except for monopolization, mergers are unprofitable. This paradox points at synergies or scale economies as the real motive for mergers. **FS** further develop the Cournot model by considering asymmetric technologies. They characterize market structures where a concentration operation raises welfare and price simultaneously. Yet, they do not to put cost asymmetries and rationalization at the forefront since they moslty deal with synergies. As already explained, our work aims at filling this gap.

To show that concentration can be socially beneficial, Daughety (1990) studies symmetrical firms that behave asymmetrically à la Stackelberg: part of the industry commits to its output at some point whereas the rest does

[7] The properties enunciated in this paragraph are proved in the appendix.

[8] The intuition lies in the fact that individual profit is convex increasing in output, thus convex decreasing in marginal cost. This means that every firm is a risk-lover when it comes to draw a technology from a distribution with fixed mean (cf. Février and Linnemer (2004) for a generalization).

so later on (apart of which all are Cournot players).[9] Huck et al. (2004) refine the argument with the idea of "commitment by governance" whereby the new firm's owner forces the managers of the formerly independent units to behave as leader and follower.

In the EU, the "safe harbor" condition bestows immunity from antitrust scrutiny if combined market shares are below 50% (cf. Parisi (2007) §III.D). Levin (1990) rationalizes it by considering a Cournot oligopoly among symmetric firms yet allowing the merged firm to behave differently afterwards.[10] Heubeck et al. (2006) improve on this feature by sticking to Cournot behavior and introducing a unique cutting-edge firm; their model is thus a particular case of ours. They compute the minimum number of merger candidates making a merger profitable and then the maximum number of merger candidates consistent with a welfare increase. The authors only prove that the two conditions are compatible with the help of a graphical plot. A shortcoming of their approach is to focus on "many firms" mergers which is a scarcely observed phenomenon. They however point out that cost efficiencies as well as the entire cost structure of the industry matter when assessing the welfare effect of a merger, a claim we are able to confirm.

Within the trade literature, a number of papers use a framework close to ours when studying international mergers but their focus is on the impact of tariff reductions (e.g. Benchekroun and Chaudhuri (2006)). An exception is Neary (2007) who considers rationalization mergers and derives our proposition 2. Similarities and differences with our work are highlighted in the text.

The literature cited up to this point emphasizes the normative aspect of mergers. There also exists a positive literature dealing with entry and merger waves, topics which fall out of the scope of our simple static one–shot game. Kamien and Zang (1990) show that monopolization is not to be expected because early acquirees require a too high price from the acquirer in anticipation that the final conglomerate will be highly profitable. More recently, Pesendorfer (2005) considers the case where a merger may lead to additional mergers in the future; his results tend to oppose those of static models. The impact of potential entry on merger profitability is taken on by Werden and Froeb (1998), Spector (2003), and Davidson and Mukherjee

[9]The author motivates this unorthodox choice by stating rather bluntly " I take as given that firms may find (this) asymmetry advantageous".

[10]The author does not explain how this change of behavior comes about. It is also noticeable that all his results are out–of–equilibrium comparative static exercises, that is to say, the preconditions may well never take place so that the conclusions may well never matter.

(2007). Endogenous mergers are studied by Qiu and Zhou (2007) for rationalization and by Motta and Vasconcelos (2005) and Banal Estañol et al. (2008) for synergies.

1.5 Rationalization

The efficiency improvement at the core of Schumpeter (1942)'s concept of "creative destruction" is rationalization. The latest US merger guidelines, which is the outcome of decades of practice, acknowledges this vision when it signals rationalization as the most substantial efficiency (cf. production reshuffling in §4, DoJ (1997)).[11] In his chapter for the Handbook of Industrial Organization, Whinston (2007) confirms the practical importance of rationalization (p 2385) when stating: *at an empirical level, oligopolistic industries (i.e., those in which mergers are likely to be scrutinized) often exhibit substantial variation in marginal cost across firms... A potentially significant source of welfare variation arising from a horizontal merger is ... the welfare changes arising from shifts of production across firms that have differing marginal costs; so-called,"production reshuffling".*

Synergies and scale economies also suffers from a weak theoretical underpinning as recognized by Farrell and Shapiro (2001) when stating (p 5) that *claimed synergies are double-edged: the same conditions that tend to make synergies more merger-specific and more beneficial to consumers also tend to make the merger itself more problematic.* In that respect, scale economies and buyer power are suspicious since they can often be achieved unilaterally. True synergies, in turn, are based on complementarities which makes the merger non horizontal and rather similar to vertical integration. Lastly, these efficiencies bear no relation to the mode or intensity of market competition. This means that any welfare loss due to "market power" can be compensated by a large enough add-hoc synergy or scale economy.[12]

The empirical literature also support rationalization vs. synergies when analyzing mergers and the general pace of industry change. In their international study, Gugler et al. (2003) find that mergers increase profits and lose market shares. Empirically, 29% of mergers are profitable and welfare-enhancing, 28% are unprofitable and inefficient, 27% are profitable and inef-

[11] Although a merger strengthening a dominant position is to be barred, authorities make an exception when the target is in hardship; this is the *failing firm defense* in the US and the *rescue merger* in the EU. This lenient policy is a recognition of the positive welfare effect of rationalization.

[12] This is actually what managers claim to gain regulatory and shareholder approval. In many cases such as Daimler–Chrysler, the acquirer ends-up reselling the target because the synergies fail to materialize.

ficient, the remaining 15% being unprofitable but efficiency-enhancing (irrational mergers undertaken by hubristic CEOs). Pesendorfer (2003), studying the paper industry, observes also that merged firms are more likely to scrap capacity subsequent to an acquisition, in accordance with rationalization. Also, a majority of acquiring firms achieve an efficiency increase following an acquisition, in accordance with synergy. Gugler and Siebert (2007) provide similar evidence from the semiconductor industry.

As summarized by Foster et al. (2008), a robust finding of studies based on business-level microdata is that within-industry reallocation and its associated firm turnover contributes substantially to industry productivity growth. The main driver of aggregate productivity changes is the reallocation of market shares to more efficient producers, either through market share shifts among incumbents, M&A or through entry and exit.[13]

2 A Model of Horizontal Merger

2.1 Specifications

A market for an homogeneous product has linear demand $D(p) = M - p$.[14] Since the empirical literature reports large and lasting productivity differences among plants (within an industry), we consider *advanced* (a) versus *bygone* (b) technologies or in efficiency terms, cutting-edge versus obsolete. For $i = a, b$, there are n_i active firms with the same constant marginal cost c_i and zero fixed cost. We let $n \equiv n_a + n_b$ denote the total number of firms and $c \equiv \frac{c_a n_a + c_b n_b}{n_a + n_b}$ the average (egalitarian) marginal cost of the industry.

The marginal cost gap $\delta \equiv c_b - c_a > 0$ can be seen as a consequence of past choices regarding R&D or internal organization (Salant et al. (1983) use $\delta = 0$). We let $Q_a^* \equiv M - c_a$ and $Q_b^* \equiv Q_a^* - \delta$ be the efficient (competitive) market outputs under the uniform use of each of the two technologies. We then define the *technological gap* as the dimensionless ratio $\gamma \equiv 2\frac{Q_a^* - Q_b^*}{Q_b^*} = \frac{2\delta}{M - c_b}$ which is approximatively the welfare loss due to the use of the obsolete technology (over the efficient one).[15] Indeed, the maximum welfare with the

[13] cf. also Bartelsman and Doms (2000) and Melitz (2003).

[14] In such a simple setting, there is no loss of generality in using a unitary slope since all cost terms can be rescaled to achieve it.

[15] Qiu and Zhou (2007) use the market size M as their main parameter for static comparative purposes.

efficient and obsolete technologies is $W_i^* = (Q_i^*)^2$ for $i = a, b$, thus

$$\frac{W_a^* - W_b^*}{W_b^*} = \frac{2Q_b^* + \delta}{Q_b^*} \frac{Q_a^* - Q_b^*}{Q_b^*} \simeq \gamma$$

Let us first characterize the equilibrium in the Cournot game of quantity competition. The FOCs of profit maximization are

$$\begin{array}{rcl} 2q_a & = & M - c_a - (n_a - 1)q_a - n_b q_b \\ 2q_b & = & M - c_b - (n_b - 1)q_b - n_a q_a \end{array} \tag{1}$$

so that the equilibrium individual quantities are

$$q_a = \frac{M - c_a + \delta n_b}{n+1} \quad \text{and} \quad q_b = \frac{M - c_b - \delta n_a}{n+1} \tag{2}$$

where we notice the production wedge $q_a - q_b = \delta$. Obsolete firms participate only if

$$q_b > 0 \Leftrightarrow M - c_b > \delta n_a \Leftrightarrow \gamma < \frac{2}{n_a} \tag{3}$$

a condition which we shall assume to hold.[16]

Total equilibrium quantity is $Q \equiv n_a q_a + n_b q_b = \frac{n}{n+1}(M - c)$ while the equilibrium price is $p = \frac{M+cn}{n+1}$. As usual with Cournot competition, it can be checked that the individual profit is $\pi_i = q_i^2$ for $i = a, b$. This means that firms are looking forward to expand their sales. We define the profit aggregates $\Pi_i \equiv n_i \pi_i$ for $i = a, b$. Since consumer surplus is $S(Q) = \frac{1}{2}Q^2$, total welfare is $W = S + \Pi_a + \Pi_b$.

2.2 Price effect of a merger

Upon merging an efficient firm to an obsolete one, we have $n'_a = n_a$ and $n'_b = n_b - 1$ since the new owner will use exclusively the efficient technology i.e., shuts down the obsolete plant. The output changes between the old and new equilibrium computed using (2) are $\Delta q_b = \Delta q_a = \frac{q_b}{n} > 0$ i.e., the increased concentration benefits all remaining firms. Yet one obsolete firm has been shut down so that the aggregate change is $\Delta Q = (n-1)\frac{q_b}{n} - q_b = -\frac{q_b}{n} < 0$. We have thus shown,

Lemma 1 *Acquisition of an obsolete firm by an efficient one raises the market price.*

[16] In the presence of many firms, if obsolete ones start to acquire the efficient technology ($n_b \searrow, n_a \nearrow$), there is a threshold at which (3) ceases to hold i.e., all the remaining obsolete firms are forced to exit. At this point, concentration would increase sharply.

Lemma 1 is a particular case of **FS**'s Proposition 2 (p. 112) stating that "If a merger generates no synergies, then it causes price to rise". The proof here shows that no matter how strong the technological asymmetry, the indirect improvement of the industry cost structure falls short of compensating the direct effect of losing one producer. In the symmetric technologies case, there is no indirect effect so that concentration reduces output and thus welfare (recall that market output is then an exhaustive indicator of welfare).

2.3 Welfare effect of a merger

The changes in the various elements constitutive of the welfare are

$$\begin{aligned}
\Delta S &= \left(Q + \tfrac{1}{2}\Delta Q\right)\Delta Q = -\left(n_a q_a + n_b q_b - \tfrac{q_b}{2n}\right)\tfrac{q_b}{n} && (4)\\
\Delta \Pi_a &= n_a(2q_a + \Delta q_a)\Delta q_a = n_a(2q_a + \Delta q_a)\tfrac{q_b}{n} && (5)\\
\Delta \Pi_b &= (n_b - 1)(q_b + \Delta q_b)^2 - n_b q_b^2 = (n_b - 1)\left(2q_b + \Delta q_b\right)\Delta q_b - q_b^2 \\
&= q_b^2\left((n_b - 1)\left(2 + \tfrac{1}{n_a + n_b}\right)\tfrac{1}{n_a + n_b} - 1\right) = \tfrac{1}{n} q_b^2\left(n_b - n_a - 1 - \tfrac{n_a + 1}{n}\right) && (6)
\end{aligned}$$

Since all variations in (4),(5),(6) are proportional to $\frac{q_b}{n}$,

$$\begin{aligned}
\Delta W \propto & -\left(n_a q_a + n_b q_b - \tfrac{q_b}{2n}\right) + n_a\left(2q_a + \tfrac{q_b}{n}\right) + \left(n_b - n_a - 1 - \tfrac{n_a + 1}{n}\right) q_b \\
= \quad & n_a q_a - \left(n_a + 1 + \tfrac{1}{2n}\right) q_b \quad = \quad n_a \delta - \left(1 + \tfrac{1}{2n}\right) q_b && (7)
\end{aligned}$$

Let us interpret (7) using the rightmost expression. The first term is the positive welfare balance brought about by efficient firms whereas the negative second term is slightly more than the output of the obsolete mothballed firm. In equilibrium, an efficient firm produces more than an obsolete one; let us call "output gap" the difference $q_a - q_b = \delta$. We have thus an intuitive condition for a merger between two asymmetric firms to be welfare improving: the combined output gap of all efficient firms $n_a\delta$ is slightly larger than the output of the retired obsolete firm. Fulfillment requires either that efficient firms are numerous enough or that their cost advantage is large enough to overcome the output loss of the retired obsolete firm. Using (2), we can rearrange (7) in terms of the fundamentals of the model:

$$\begin{aligned}
\Delta W > 0 \quad \Leftrightarrow \quad & n_a\left(M - c_a + \delta n_b\right) \quad > \quad \left(M - c_b - \delta n_a\right)\left(n_a + 1 + \tfrac{1}{2n}\right) \\
\Leftrightarrow \quad & n_a\left(M - c_b + \delta(n_b + 1)\right) \quad > \quad \left(M - c_b - \delta n_a\right)\left(n_a + 1 + \tfrac{1}{2n}\right) \\
\Leftrightarrow \quad & \left(M - c_b\right)\left(1 + \tfrac{1}{2n}\right) \quad > \quad \delta n_a\left(n + 2 + \tfrac{1}{2n}\right) \\
\Leftrightarrow \quad & \frac{2\delta}{M - c_b} = \gamma \quad > \quad \lambda_{a,b} \equiv \frac{2}{n_a}\frac{1 + 2n}{1 + 4n + 2n^2} && (8)
\end{aligned}$$

We have thus shown,

Proposition 1 *Acquisition of an obsolete firm by an efficient one raises welfare if and only if the technological gap is larger than the threshold* $\lambda_{a,b}$.

Compatibility with the condition for participation of obsolete firms is achieved since $\lambda_{a,b} < \frac{2}{n_a}$ (cf. eq. (3)). Table 1 in the Appendix displays the rather low percentage values of the threshold $\lambda_{a,b}$ for combinations of obsolete (b) and cutting-edge (a) firms.

2.4 Profitability of a merger

Stigler (1950) famously said that "the promoter of a merger is likely to receive much encouragement from each firm, ..., except participation"; this is because in the present framework, there is more to gain by remaining an outsider to a merger rather than being an insider.[17] To avoid complications, we disregard such an anticipation and study the profitability of a merger among myopic firms i.e., we focus on exogenous mergers instead of endogenous ones.

For a merger between two asymmetric firms, the profit change from the *pre* to the *post* merger situation is

$$\begin{array}{rcccl} \Omega & \equiv & \pi_a' - \pi_a - \pi_b & = & \left(q_a + \frac{q_b}{n}\right)^2 - q_a^2 - q_b^2 \\ & = & \frac{2q_a q_b}{n} - \left(1 - \frac{1}{n^2}\right) q_b^2 & = & \frac{q_b}{n^2}\left(2nq_a - (n^2-1)q_b\right) \end{array} \tag{9}$$

Using (2), we can rearrange (9) as

$$\begin{array}{rcl} \Omega > 0 & \Leftrightarrow & 2n\left(M - c_b - \delta + \delta n_b\right) > \left(n^2-1\right)\left(M - c_b - \delta n_a\right) \\ & \Leftrightarrow & \left(M - c_b\right)\left(n^2 - 2n - 1\right) < \delta\left(n\left(2n_b + nn_a\right) - 2n - n_a\right) \\ & \Leftrightarrow & \dfrac{2\delta}{M - c_b} = \gamma \quad > \quad \mu_{a,b} \equiv 2\dfrac{n^2 - 1 - 2n}{2n(n_b+1) + \left(n^2-1\right)n_a} \end{array} \tag{10}$$

We have thus shown,

Proposition 2 *Acquisition of an obsolete firm by an efficient one is privately profitable if and only if the technological gap is larger than the threshold* $\mu_{a,b}$.

This proposition is independently derived by Neary (2007) who interprets it as the technology gap between two countries (e.g., advanced vs. developing) that triggers cross border mergers. Table 2 in the Appendix illustrates the technological gap required for (10) to hold. We also notice in the last row the compatibility of (10) with the condition (3) for participation of obsolete firms.

[17] This observation is at the root of Salant et al. (1983)'s well known merger paradox.

2.5 Private vs. Social suitability of a merger

To find out under what circumstances a price raising merger (between firms #1 and #2) nevertheless increases welfare, **FS** uses the "external effect" approach: they presume a privately beneficial merger and then proceed to derive a sufficient condition on pre-merger market shares; they obtain

$$\frac{q_1+q_2}{Q} \leq -\sum_{i\geq 3} \frac{q_i \mathrm{d}q_i}{Q \mathrm{d}Q} \tag{11}$$

In the general Cournot model with constant returns to scale for the non-merging firms, it can be shown that $\frac{q_1+q_2}{Q} \leq \frac{1}{2}$ is a sufficient condition for (11). For a linear demand, this condition is also necessary. Thus, quoting **FS**,

Lemma 2 *A privately profitable merger involving at most half the industry is socially desirable.*

For policy purposes, the "external effect" approach is attractive as it enables to elude the computation of the merger efficiency which is a private information hardly accessible to antitrust authorities. However, this method has a serious drawback in that the presupposition might be empty in which case Lemma 2 is a void statement. **FS** recognize this risk when applying (11) to Salant et al. (1983)'s linear symmetric Cournot model where it is well known that a profitable merger must involve at least 3/4 of the industry.[18] In our model, it is possible to solve the issue analytically. A privately profitable merger is welfare improving if $\mu_{a,b} \geq \lambda_{a,b}$

$$\begin{aligned} \Leftrightarrow \quad 0 \leq & \quad n_a \left(n+2+\tfrac{1}{2n}\right)\left(n-\tfrac{1}{n}-2\right) - \left(1+\tfrac{1}{2n}\right)\left(2(n_b+1)+\left(n-\tfrac{1}{n}\right)n_a\right) \\ \Leftrightarrow \quad 0 \leq & \quad n_a\left(n_a+1\right)\left(n_a-3\right) - 1 + n_a n_b^2 + 2n_b\left(n_a^2-n_a-1\right) \end{aligned} \tag{12}$$

whose solution is $n_a + n_b \geq 5$ or ($n_a + n_b = 4$ and $n_a > 1$).[19] Notice then that the solution to (12) agrees with (11) i.e., in all acceptable combinations (n_a, n_b), the pre-merger combined market share of an efficient and an obsolete firm is less than 50%. We have thus shown,

[18] One must take care of not interpreting Lemma 2 as: *a merger involving at most half the industry is socially desirable but won't materialize because it is not profitable for its promoters.*

[19] The relevant root of (12) is $n_b = f(n_a) \equiv \frac{n_a - n_a^2 + 1 + \sqrt{3n_a + 2n_a^2 + 1}}{n_a}$ which satisfies $f(1) \simeq 3.4$, $f(2) \simeq 1.4$, $f(3) \simeq 0.1$ and $f(n_a) < 0$ for $n_a > 3$. Since $n_i \geq 1$ for $i = a, b$, the result follows.

Proposition 3 *The privately profitable acquisition of an obsolete firm by an efficient one is welfare enhancing if and only if the industry counts at least 5 firms or exactly 4 of which at least 2 are efficient.*

Proposition 3 is a corollary of Lemma 2 recalling us that in the linear Cournot setting, firms tend to be of equal size, even in the presence of cost asymmetries. Hence, only four market structure combinations of obsolete and efficient firms are eliminated (cf. underlined entries in Table 2). In other words, almost any privately profitable merger is socially desirable if the industry has at least five participants. Bringing together our propositions, we obtain:

Corollary 1 *In an industry whose structure satisfies (12), if the technology gap is*

- $\gamma \leq \lambda_{a,b}$*: a merger is unprofitable and a source of dead weigth loss.*
- $\lambda_{a,b} < \gamma \leq \mu_{a,b}$*: a merger is welfare enhancing but still unprofitable.*
- $\mu_{a,b} < \gamma \leq \frac{2}{n_a}$*: a merger is welfare enhancing and profitable.*
- $\gamma > \frac{2}{n_a}$*: obsolete firms are expelled from the market by efficient ones.*

The contraposition of Corollary 1 is that some profitable mergers are welfare regressive contrary to Neary (2007)'s claim p1244 that "since only high-cost firms are eliminated, the increase in production efficiency ensures that the rise in profits dominates the fall in consumer surplus."[20] This will be the case for the underlined entries of Table 2 when $\gamma > \mu_{a,b}$.

2.6 Synergy

Given the competing roles of *synergy* and *rationalization* as alternatives forms of efficiency, it is worthwhile comparing them in our framework. Although the US merger guidelines singles out rationalization as the prime source of efficiency, it also contemplates synergies when considering the possibility for two obsolete firms to merge and thereby succeed to upgrade their technology,[21] which we refer to as a *catching-up* merger.

[20] Neary (2007) only states the claim and refers the reader to Lahiri and Ono (1988) but in this latter article, the exact computation is absent.

[21] cf. DoJ (1997): "For example, merger-generated efficiencies may enhance competition by permitting two ineffective (e.g., high cost) competitors to become one effective (e.g., lower cost) competitor." The newly merged firm could even *leapfrog* the current best technology.

In this situation, we have $n'_a = n_a + 1$ and $n'_b = n_b - 2$. Using the individual output formulas (2), we find $\Delta q_a = \Delta q_b = -\Delta Q = \frac{q_b - \delta}{n} \equiv z$. The changes in the various elements constitutive of the welfare are

$$\begin{array}{lcl} \Delta S & = & \left(Q + \frac{1}{2}\Delta Q\right)\Delta Q = -\left(Q - \frac{1}{2}z\right)z \\ \Delta\Pi_a & = & (n_a+1)(2q_a + \Delta q_a)\Delta q_a + q_a^2 = n_a(2q_a + z)z + q_a^2 \\ \Delta\Pi_b & = & (n_b - 2)\left(2q_b + \Delta q_b\right)\Delta q_b - 2q_b^2 = (n_b - 2)\left(2q_b + z\right)z - 2q_b^2 \end{array}$$

thus $\Delta W = z\left(\frac{1}{2}z - Q + n_a(2q_a + z) + (n_b - 2)\left(2q_b + z\right)\right) + q_a^2 - 2q_b^2 = \Phi z + B$ with

$$\begin{array}{lcl} B & \equiv & q_a^2 - 2q_b^2 = (q_a + 2q_b)(q_a - 2q_b) = -(3q_b + \delta)(q_b - \delta) = -(3q_b + \delta)nz \\ \Phi & \equiv & \frac{1}{2}z - Q + n_a(2q_a + z) + (n_b - 2)(2q_b + z) = Q - 4q_b + z\left(n - \frac{3}{2}\right) \end{array}$$

so that expanding z we obtain

$$\begin{array}{lcl} \frac{\Delta W}{z} & \propto & n_a q_a + n_b q_b - 4q_b + \frac{q_b - \delta}{n}\left(n - \frac{3}{2}\right) - (3q_b + \delta)n \\ & = & n_a\delta + nq_b - (3q_b + \delta) - \frac{3}{2}\frac{q_b - \delta}{n} - (3q_b + \delta)n \\ & = & \delta\left(\frac{3}{2n} - 1 - n_b\right) - q_b\left(2n + 3 + \frac{3}{2n}\right) < 0 \quad \text{since } \frac{3}{2n} < 1 + n_b \end{array}$$

We now look at private profitability. To the extend that the emulation of the advanced technology is costless or free of charge, the profitability of a synergy merger is given by

$$\Upsilon \equiv q_a^{'2} - 2q_b^2 \propto q'_a - 2q_b = \Delta q_a + q_a - 2q_b = z - (q_b - \delta) = -(n-1)z$$

thus has the same sign as ΔW. To conclude $\Delta W > 0$ and $\Upsilon > 0$ if and only if

$$z < 0 \quad \Leftrightarrow \quad q_b < \delta \quad \Leftrightarrow \quad \gamma \quad > \quad \rho_{a,b} \equiv \frac{2}{2n_a + n_b + 1} \qquad (13)$$

using again formula (2). We have thus shown,

Proposition 4 *A catching-up synergy merger is profitable and raises welfare if and only if the technological gap is larger than the threshold $\rho_{a,b}$.*

We can now compare synergy and rationalization mergers in their relation to existing cost asymmetries in the industry. Regarding profitability, it is a matter of algebra to show that $\mu_{a,b} - \rho_{a,b}$ is proportional to $n(n-4) - 1$; it is thus positive if and only if $n \geq 5$. Regarding welfare, we can show that $\rho_{a,b} - \lambda_{a,b}$ is proportional to $2n(n_a - 1) - 1$; it is thus positive if and only if $n_a > 1$. To cluster these findings assume $n \geq 5$ and $n_a > 1$ so that $\lambda_{a,b} < \rho_{a,b} < \mu_{a,b}$ is true. For a small technology gap ($\lambda_{a,b} < \gamma < \rho_{a,b}$), both

types of mergers are unprofitable but the rationalization merger is welfare enhancing. For an intermediate technology gap ($\rho_{a,b} < \gamma < \mu_{a,b}$), both types of mergers are welfare enhancing but only the synergy merger is profitable. In other words, welfare increases faster with the technology gap under rationalization whereas profitability increases faster with the technology gap under synergy. Summarizing, we obtain the following corollary:

Corollary 2 *In an industry counting at least five firms of which more than one is advanced, a rationalization merger is more likely to be welfare enhancing but a synergy merger is more likely to be profitable.*

Another way to explain why a synergy merger can be profitable is to reason that it is analytically equivalent to the following two-step procedure: an obsolete firm innovates which is both welfare improving and profitable (cf. Proposition 5). Then, the newly efficient firm acquires an obsolete one; this is welfare improving and profitable under the conditions of propositions 1–3. Since the first step involves both a private and social gain, the welfare or profit hurdle for the second step ought to be easier to pass. However, the market structure is different at the start of the two steps so that no immediate conclusion is available.

2.7 Innovation

In our simple setting, rationalization is either production reshuffling with closure of the obsolete plant or knowledge diffusion with the upgrading of the obsolete plant towards the cutting-edge technology. The second interpretation being linked to innovation, it makes sense to contrast our previous findings with internal technical progress i.e., self-innovation.

When an obsolete firm succeeds to lower its marginal cost, the market structure becomes $n'_a = n_a + 1$ and $n'_b = n_b - 1$. We observe from formula (2) that $\Delta q_a = \Delta q_b = \frac{-\delta}{n+1} < 0$ i.e., all firms but the innovative one produce less, yet $\Delta Q = \frac{\delta}{n+1} > 0$ because the innovator increases its supply by $q_a - q_b = \delta$. Hence, the innovation favors consumer surplus. One cannot, however, conclude immediately that welfare increases since the technology upgrade intensifies market rivalry which hurts all the other firms. We thus need to compute exactly the welfare change. Using again (2) and denoting $z = M - c_b$, we have $q_a = \frac{z+\delta(n_b+1)}{n+1}$, $q_b = \frac{z-\delta n_a}{n+1}$, $q'_a = \frac{z+\delta n_b}{n+1}$ and $q'_b =$

$\frac{z-\delta(n_a+1)}{n+1}$ thus

$$\begin{aligned}(n+1)^2\,\Delta S &= \left(n_a\,(z+\delta)+n_b z+\tfrac{1}{2}\delta\right)\delta\\ (n+1)^2\,\Delta\Pi_a &= (n_a+1)\,(z+\delta n_b)^2-n_a\,(z+\delta(n_b+1))^2\\ (n+1)^2\,\Delta\Pi_b &= (n_b-1)\,(z-\delta(n_a+1))^2-n_b\,(z-\delta n_a)^2\end{aligned}$$

Letting $\Psi \equiv 2n_a\,(n_a+2)-2n_b\,(n_b+1)+1$, we obtain

$$\Delta W \propto 2z(n+2)-\delta\Psi = (M-c_b)\left(2(n+2)-\tfrac{\gamma\Psi}{2}\right) \quad \text{as } \gamma=\tfrac{2\delta}{M-c_b}$$

Hence the innovation is welfare improving if and only if $4(n+2)>\gamma\Psi$ which is true whenever $\Psi<0$ i.e., there are not so many efficient firms. To show that this still holds true when $\Psi>0$ (i.e., when n_a is large), we use the fact that $\gamma<\frac{2}{n_a}$ (cf. (3)). We then only need to prove the sufficient condition $4(n+2)>\frac{2}{n_a}\Psi$ which, as one can check from the definition of Ψ, is trivially satisfied. It is only when several obsolete firms are forced to exit (violation of (3)) that welfare might drop because concentration jumps abruptly. We thus obtain:[22]

Proposition 5 *Innovation by an obsolete firm towards the efficient technology is socially desirable and lowers the price.*

The last possibility we consider is when two obsolete firms merge without any technological improvement. We have $n'_a=n_a$ and $n'_b=n_b-1$ since the new owner will use either of the two obsolete technologies (but not both). From a market outcome point of view, the disappearance of an obsolete firm is as if an advanced firm had bought it; hence the results of lemma 1 and proposition 1 regarding price and welfare remain valid. To see that such a merger is unprofitable, we study

$$\chi \equiv \pi'_b-2\pi_b \propto (q_b+\Delta q_b)^2-2q_b^2=\left(\left(1+\tfrac{1}{n}\right)^2-2\right)q_b^2$$

and notice that $\chi<0\Leftrightarrow n>2$. If there are only obsolete firms ($n_a=0$), we fall back on the Salant et al. (1983) paradox when only a duopoly merging to monopoly is profitable. Otherwise, there is at least one efficient firm and at least the two merging obsolete ones, so that the condition holds. Our framework thus yields a more clear cut result than proposition 3 of Heubeck et al. (2006).

Proposition 6 *A non innovative merger between two obsolete firms is unprofitable.*

[22] A similar possibility is hinted at by Lahiri and Ono (1988).

3 Conclusion

That a merger can increase market power and the productive efficiency of the industry at the same time is well understood. However, the impact on welfare of these opposing forces is hard to disentangle because they work at different levels. The market power offense is direct and easy to grasp: in the Cournot model of oligopolistic competition (as well as in most other IO models), higher concentration leads to a higher equilibrium price and a lower consumer surplus. The efficiency defense suffers from a more convoluted reasoning as it works indirectly: a merger bestows insiders with the opportunity to improve their technology, thus reduce their cost and become fiercer competitors. This tends to lower the price and generate profit gains that MAY overcome the aforementioned consumer surplus loss.

In this paper, we simplify the Farrell and Shapiro (1990) framework to pinpoint the necessary degree of efficiency improvement (rationalization) for the previous assertion to be true. We also make a methodological point by leveling the playing field between the market power offense and the efficiency defense regarding the welfare effects of mergers. Our framework, like most of the literature, employs the highly stylized Cournot model; needless to say, its implications for antitrust policy should be handled with care. Several limitations are worth mentioning.

Firstly, we take welfare to be the adequate social objective whereas consumer surplus was historically the focus of antitrust authorities; in that latter case, theoretical conclusions are clear-cut since a merger involving large firms and without significant synergies ought to be barred. Secondly, an obvious shortcoming of assuming constant marginal cost is that upon being acquired an obsolete firm is shut down and the only advantage for the acquirer is to reduce market rivalry.[23] In real mergers, it is rare to see all the assets of the acquired firm being divested. Rather, inefficient plants are closed or re-organized with injections of human and physical capital. Thirdly, the linear Cournot model, even with asymmetric cost, tends to give similar market shares in equilibrium to all firms. The real impact of technological asymmetries is thus probably stronger but since it might increase both the "market power" and the "dynamic efficiency" effects of a merger, it remain difficult to sign. Fourthly, our analysis disregards fixed costs altogether which play a crucial part in the assessment of synergies and scale economies brought about by mergers. Fifth of all, we consider exogenous

[23] Because this property is a public good, outsiders to the merger free-ride on the insiders to the merger without having to support the cost.

mergers and not endogenous one i.e., we do not allow for reactions such as entry or exit after mergers. Lastly, although we discourse at length about dynamic efficiency, our approach is static; it thus neglects the fact that concentration operations tend to facilitate collusion by reducing the number of people involved.

Appendix

Properties of the Cournot equilibrium under asymmetric cost

Let $D(.)$ be the market demand and $P(.)$ its inverse, the willingness to pay. There are n active firms with constant marginal cost c_i for $i \leq n$. We denote $Q \equiv \sum_{i \leq n} q_i$ the aggregate output, $\epsilon \equiv \frac{-P}{QP'}$ the elasticity of demand, $H \equiv \sum_{i \leq n} \left(\frac{q_i}{Q}\right)^2$ the HHI concentration index, $\pi_i = q_i(p - c_i)$ the individual profit, $\Pi \equiv \sum_{i \leq n} \pi_i$ the aggregate profit and $\bar{c} \equiv \frac{1}{n} \sum_{i \leq n} c_i$ the average marginal cost.

The FOC of profit maximization is

$$P(Q) + q_i P'(Q) = c_i \Rightarrow p - c_i = \frac{pq_i}{\epsilon Q} \tag{14}$$

thus

$$\pi_i = q_i(p - c_i) = \frac{pQ}{\epsilon} \left(\frac{q_i}{Q}\right)^2 \Rightarrow \Pi = \frac{pQ}{\epsilon} H \tag{15}$$

which is the Cowling and Waterson (1976) formula (notice that they use a model of quantity competition à la Cournot with conjectural variations).

FOC (14) also reads $\frac{q_i}{Q} = \epsilon \frac{p - c_i}{p}$, thus

$$H = \epsilon^2 \sum_{i \leq n} \left(\frac{p - c_i}{p}\right)^2 \Rightarrow \frac{p^2 H}{\epsilon^2} = \sum_{i \leq n} (p - \bar{c} + \bar{c} - c_i)^2 = n\,(p - \bar{c})^2 + n\sigma_c^2 \tag{16}$$

where σ_c^2 is the variance of the sample of marginal costs. Observe now that summing (14), we obtain $n(p - \bar{c}) = \frac{p}{\epsilon}$. Plugging in (16), we get $\frac{p^2 H}{\epsilon^2} = \frac{p^2}{n\epsilon^2} + n\sigma_c^2$, thus

$$H = \frac{1}{n} + \frac{n\epsilon^2 \sigma_c^2}{p^2} = \frac{1}{n} + \frac{(1 - n\epsilon)^2}{n} v_c^2 \tag{17}$$

where v_c is the coefficient of variation. This is the Clarke and Davies (1982) formula.

Salant and Shaffer (1999) observe that summing the left version of (14), one gets $P(Q)+\frac{1}{n}QP'(Q) = \bar{c}$ i.e., aggregate output Q and consumer surplus S depend on $\bar{c}$ only. Now, by combining (15) and (17), we get $\frac{n\epsilon}{pQ}\Pi = 1+(1-n\epsilon)^2 v_c$. When $\bar{c}$ is constant, so are Q, p, ϵ, thus welfare $W = \Pi + S$ increases with dispersion of technologies. The limit is reached when a maximum number of firms are driven out of the market (or at least lose their economic rent) while the remaining ones achieve zero marginal cost, a result in the line of Cournot's observation regarding industry cost.

Numerical Values for Thresholds

For n_b obsolete (b) and n_a cutting-edge (a) firms, we have

n_b \ n_a	1	2	3	4	5	6	7	8
1	59	23	12	8	5	4	3	2
2	45	18	10	7	5	4	3	2
3	37	15	9	6	4	3	2	2
4	31	13	8	5	4	3	2	2
5	27	12	7	5	3	3	2	2
6	24	11	6	4	3	2	2	2
$\frac{2}{n_a}$	200	100	67	50	40	33	29	25

Table 1: Minimum technology gap (in %) for a welfare improving merger

n_b \ n_a	1	2	3	4	5	6	7	8
1	-18	14	23	24	23	22	20	18
2	15	26	27	26	24	22	20	19
3	30	32	30	27	25	22	20	19
4	38	35	32	28	25	23	21	19
5	43	38	33	29	26	23	21	19
6	47	39	34	29	26	23	21	19
$\frac{2}{n_a}$	200	100	67	50	40	33	29	25

Table 2: Minimum technology gap (in %) for a profitable merger

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